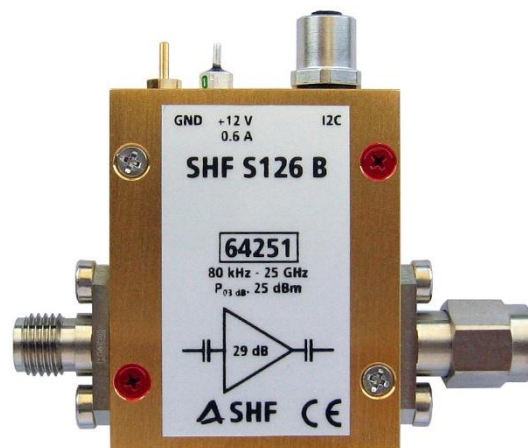


Data Sheet

SHF S126 B



Broadband Amplifier



Description

The SHF S126 B broadband amplifier is the successor of the popular SHF S126 A. By applying a new input-stage MMIC, this amplifier keeps the RF bandwidth and output power at the same high level as the predecessor while enhancing the input reflection.

Data rates up to 32 Gbps with output amplitudes of up to 12 V are possible.

The S126 B is a two-stage amplifier design, using proprietary monolithic microwave integrated circuits (MMICs) inside. An internal voltage regulation protects the amplifier against accidental reverse voltage connection and makes it robust against line voltage ripple.

Ease of Use

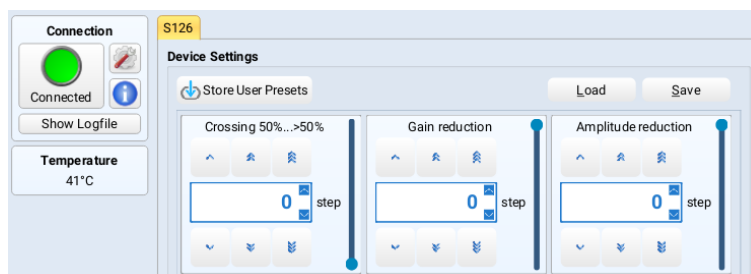
Only a single 12 V supply is needed for operation.

Upon delivery, the amplifier is already pre-set to deliver maximum gain, maximum output amplitude and nominally 50% crossing.

These settings can be modified in an easy to use graphical user interface, as shown below. For connecting the amplifier to the computer, the USB to I2C converter cable, as well as the required software are included with each amplifier with no extra charge.

Once new settings are stored on the device the amplifier will remember the settings until further changes are made. There is no need to connect a computer to the device unless gain, maximum amplitude or crossing adjustments are to be made.

The software is available for download at www.shf-communication.com.



GUI of the Control Center (SCC)

Individual Inspection

Each amplifier will be furnished with an individual inspection report showing the compliance to the data sheet as well as the time- and frequency domain performance. This data (including the touchstone® s2p-file) is accessible on-line. The specific link dedicated to each serial number will be provided with the delivery and is printed as a QR code on the heat sink.



Options

- 01: DC return on input (max. ± 1.75 V, max. 35 mA)¹
- 02: Built-in bias tee on input (max. ± 9 V, max. 220 mA)¹
- 03: DC return on output (max. ± 1.75 V, max. 35 mA)¹
- 04: Built-in bias tee on output (max. ± 9 V, max. 220 mA)¹
- MP: Matched Pair of two amplifiers

¹ The options 01 & 02 or 03 & 04 cannot be combined.

If an option is chosen, the maximum gain, the maximum output power and the reflections might be reduced by up to 1 dB.
The DC resistance of a bias tee is about 3 Ω .



Specifications

Absolute Maximum Ratings

Parameter	Unit	Symbol	Min	Typ	Max	Comment
Maximum RF Input	dBm	$P_{in\ max}$			4	
	V				1	peak to peak voltage
DC Voltage at RF Input	V				±9	
DC Voltage at RF Output	V				±9	
Positive Supply Voltage	V		11		13	current depends on voltage typ. 0.55 A at 12.0 V, allow 1 A
Case Temperature	°C	T_{case}	10	45	50	mounted Heatsink is part of delivery

Electrical Characteristics (At 45°C case temperature, unless otherwise specified)

Parameter	Unit	Symbol	Min	Typ	Max	Comment
High Frequency 3 dB Point	GHz	f_{High}	25			At $P_{in}=-30$ dBm
Low Frequency 3 dB Point	kHz	f_{Low}			80	At $P_{in}=-30$ dBm
Gain	dB	S_{21}	28	29		non-inverting At $P_{in}=-30$ dBm and 500 MHz
Max. Gain Reduction	dB		1.5	2		Control via software interface
Input Reflection	dB	S_{11}			-12	0.5 MHz < f ≤ 16 GHz
					-8	16 GHz < f ≤ 25 GHz
Output Reflection	dB	S_{22}			-12	0.5 MHz < f ≤ 12 GHz
					-5	12 GHz < f ≤ 20 GHz
Output Power at 1 dB Compression	dBm	P_{01dB}	23			50 MHz ≤ f ≤ 16 GHz
	V		8.9			peak to peak voltage
Output Power at 2 dB Compression	dBm	P_{02dB}	24			50 MHz ≤ f ≤ 16 GHz
	V		10			peak to peak voltage
Output Power at 3 dB Compression	dBm	P_{03dB}	25			50 MHz ≤ f ≤ 16 GHz
	V		11.2			peak to peak voltage
Jitter	fs	JRMS			850	$V_{out} \sim 12$ V @ 32 Gbps Deconvoluted ^{2,3}
					900	Full setup ²
Crossing Control Range	%		0		10	Control via software interface @ 450 mV input signal amplitude

² Measured with the following setup: SHF C911 A DAC -> DUT (SHF S126 A) -> Agilent 86100A with 70 GHz sampling head and precision time base.

³ Calculation based on typical results of setup without DUT: $J_{RMS\ deconvoluted} = \sqrt{(J_{RMS\ full\ setup})^2 - (J_{RMS\ setup\ w/o\ DUT})^2} = \sqrt{(J_{RMS\ full\ setup})^2 - 300\ fs^2}$



Parameter	Unit	Symbol	Min	Typ	Max	Comment
Phase Delay Difference ⁴	deg	Δ PD			5	1 GHz to 16 GHz If option MP is chosen
Gain Difference ⁵	dB	Δ S ₂₁			1	1 to 16 GHz If option MP is chosen
Power Consumption	W			6.5		12 V supply voltage

Mechanical Characteristics

Parameter	Unit	Symbol	Min	Typ	Max	Conditions
Input Connector	Ω			50		2.92 mm (K) female ⁶ Option VFVM: 1.85 mm female
Output Connector	Ω			50		2.92 mm (K) male ⁶ Option VFVM: 1.85 mm male
Dimensions	mm					see page 11 to 12
Weight	g			30 315		Amplifier only Heat Sink only

Output Amplitude Adjustment

The output amplitude can be adjusted using the GUI. The maximum possible reduction depends on the output amplitude itself; for example, a minimum input power of -3 dBm is required to achieve an output power reduction of at least 4 dB. Lower output power levels will result in a reduced range of output power reduction. When using the amplitude adjustment, the crossing might also require a fine adjustment.

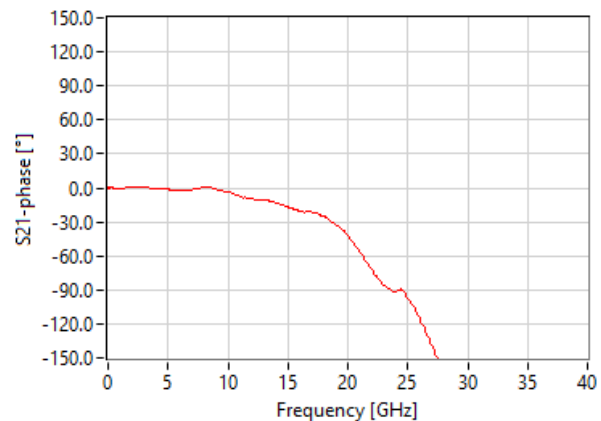
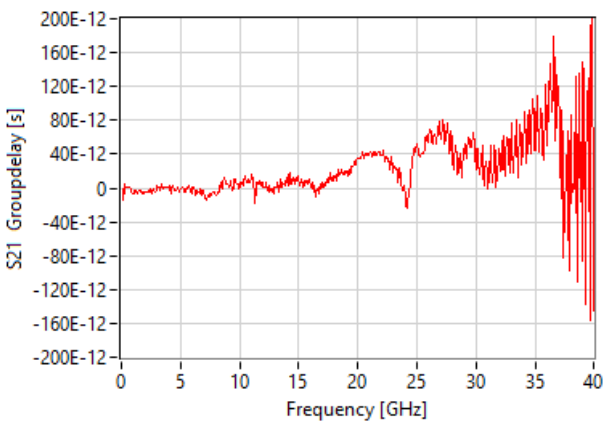
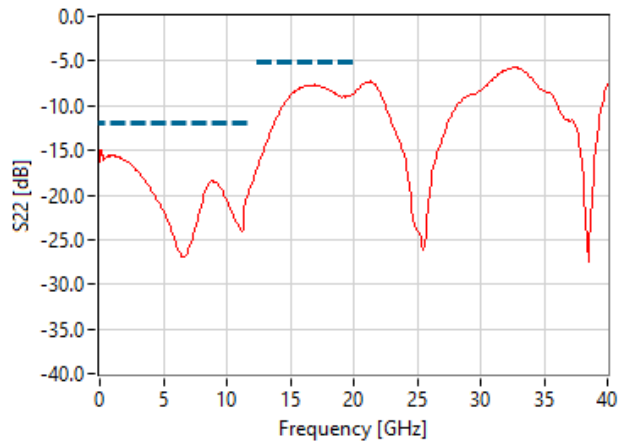
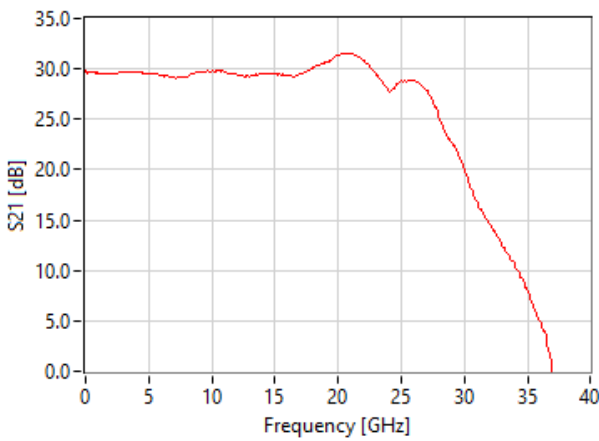
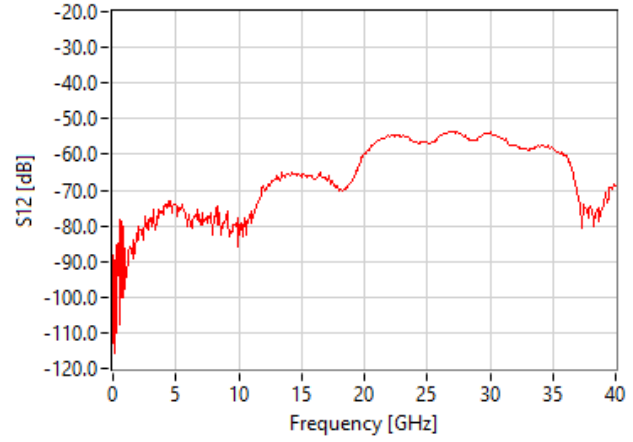
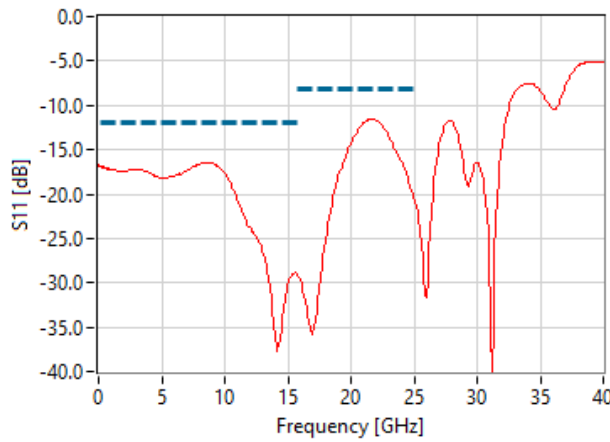
⁴ The phase delay difference is defined as the phase difference in degrees of the output signals of both amplifiers. It is calculated as: $\Phi_{Amp1} - \Phi_{Amp2}$, where Φ_{Amp1} and Φ_{Amp2} indicate the unwrapped phase of S_{21 Amp1} and S_{21 Amp2}, respectively.

⁵ The gain difference is defined as the gain difference in dB of the output signals of both amplifiers. It is calculated as: $|S_{21 Amp1}|_{dB} - |S_{21 Amp2}|_{dB}$.

⁶ Other gender configurations are available on request.



Typical S-Parameters



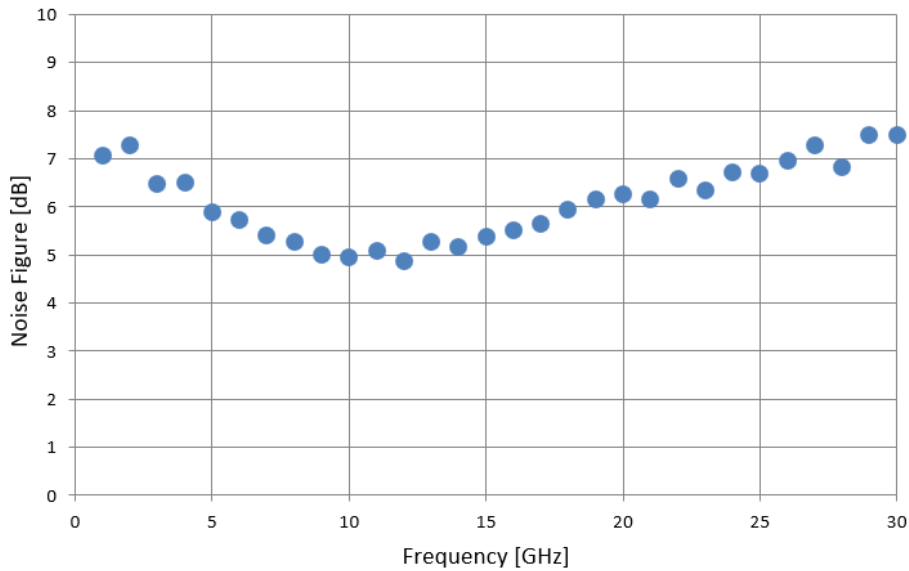
S-Parameters are part of the inspection report for each individual amplifier.

Blue dashed lines = Specifications

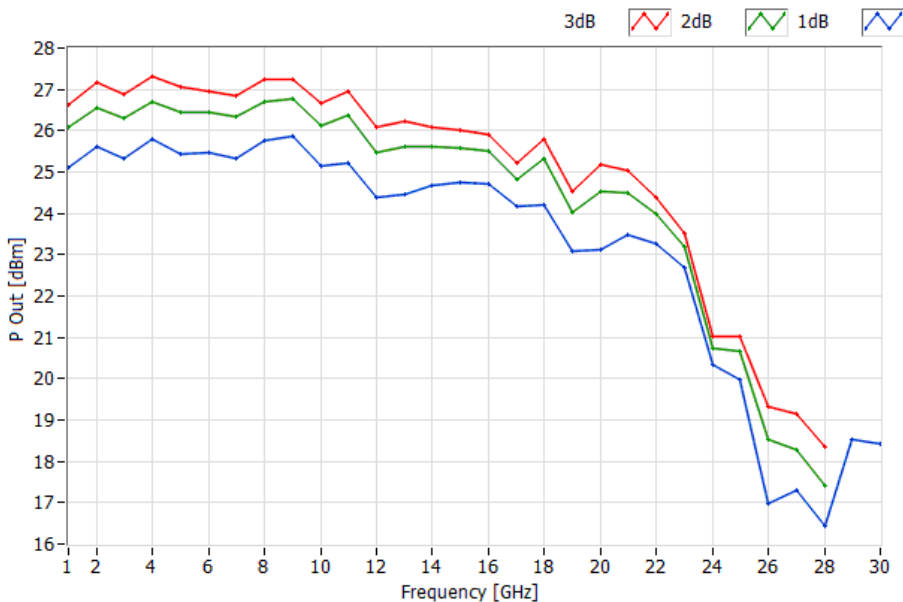


Typical Noise Figure

The measurement had been performed using a FSW85 Spectrum Analyzer by Rhode & Schwarz. The noise figure defines the extent to which the signal-to-noise ratio degrades when the signal passes through an amplifier. An ideal amplifier would amplify the noise at its input, as well as the signal. However, a real amplifier introduces additional noise from its components, which degrades the signal-to-noise ratio. Please note that this only applies to small signals. When the amplifier is used close to or in its saturation region, additional non-linear effects impact the signal-to-noise ratio and the signal waveform.



Typical Saturation Power



Top (red): 3 dB compression;
Middle (green): 2 dB compression;
Bottom (blue): 1 dB compression



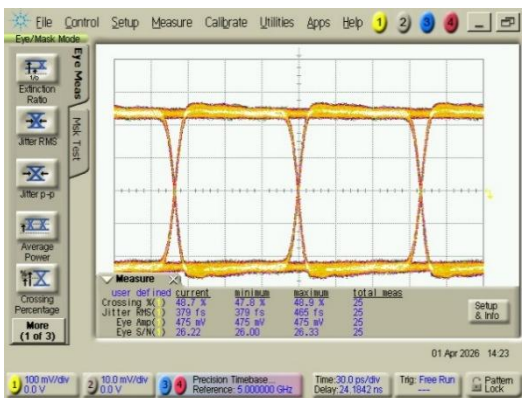
Typical Waveforms

The following measurements had been performed using the hardware mentioned below. The output of the amplifier had been connected with an attenuator (10 + 20 dB) to the scope's sampling module.

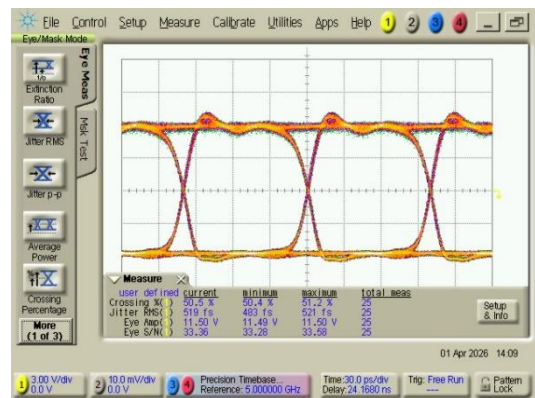
The measurements at 10, 20 and 32 Gbps will be part of each inspection report.

Measurements with:

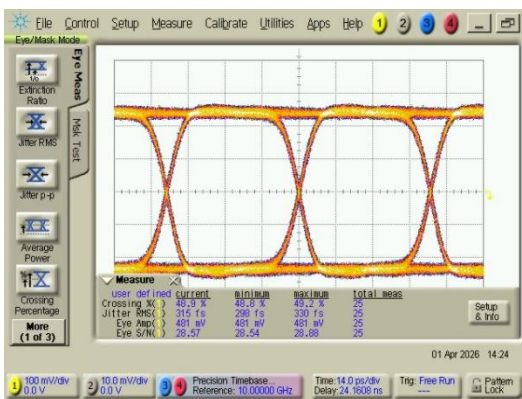
- SHF C911 A DAC generating binary signals (PRBS 2³¹-1)
- Agilent DCA 86100D with PTB 86107A and Sampling Head 86118A
- No Filter applied



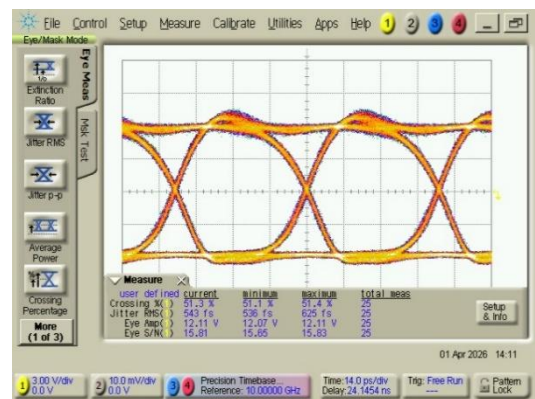
10 Gbps 475 mV Input Signal



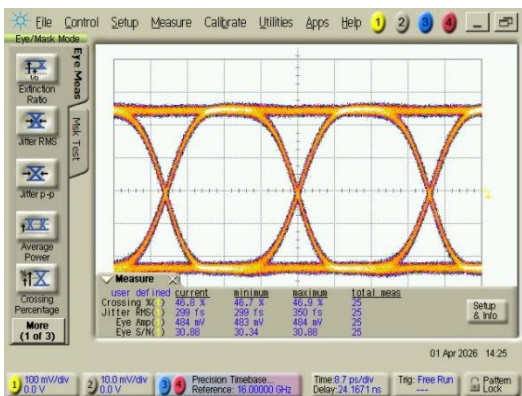
10 Gbps 11.5 V Output Signal



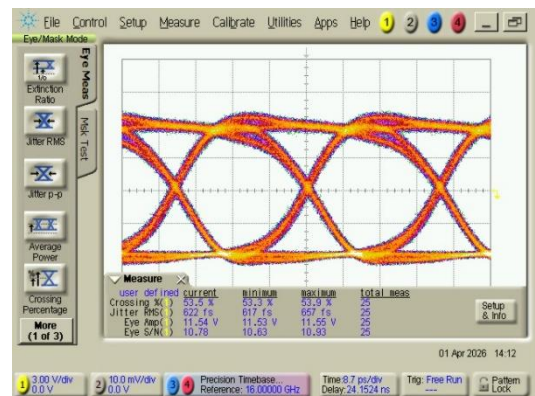
20 Gbps 480 mV Input Signal



20 Gbps 12.1 V Output Signal



32 Gbps 480 mV Input Signal



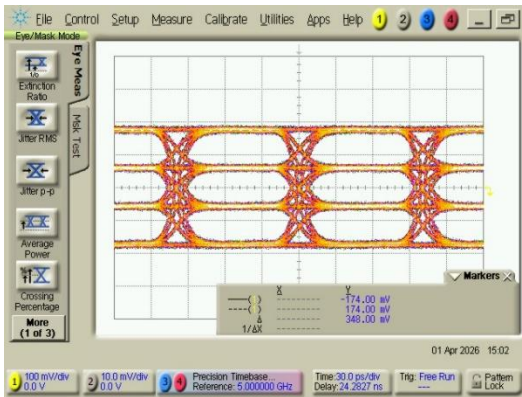
32 Gbps 11.5 V Output Signal



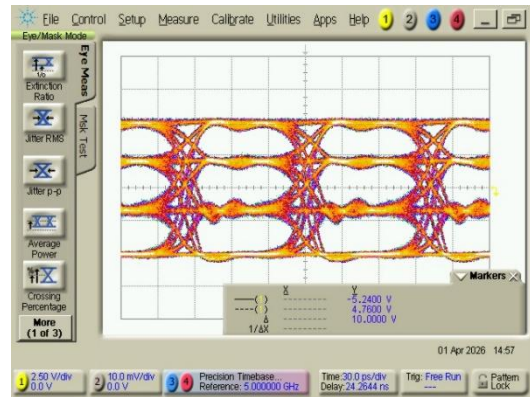
The following measurements had been performed using the hardware mentioned below. The output of the amplifier had been connected with an attenuator (10 + 20 dB) to the scope's sampling module.

Measurements with:

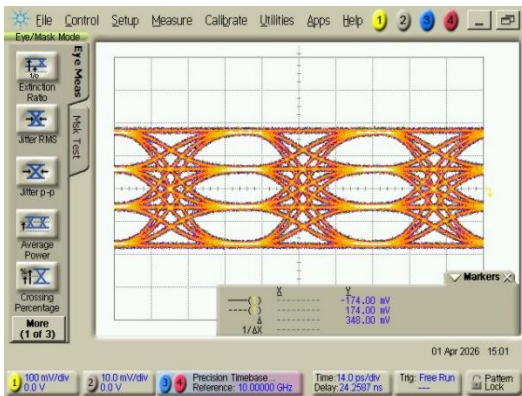
- SHF C911 A DAC generating PAM4 signals (PRBS 2³¹-1)
- Agilent DCA 86100D with PTB 86107A and Sampling Head 86118A
- 17 GHz low pass filter at DAC's output



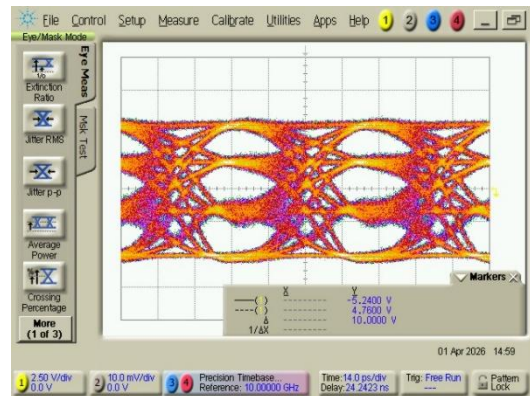
10 GBaud (20 Gbps) 350 mV Input Signal



10 GBaud (20 Gbps) 10 V Output Signal



20 GBaud (40 Gbps) 350 mV Input Signal



20 GBaud (40 Gbps) 10 V Output Signal

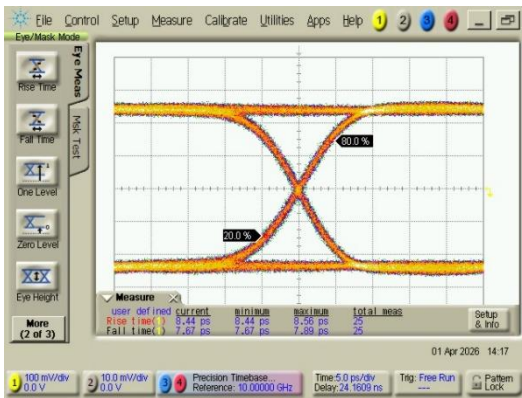
Typical Rise and Fall Time

The following measurements had been performed using the hardware mentioned below. The output of the amplifier had been connected with an attenuator (10 + 20 dB) to the scope's sampling module.

The measurement shows the typical rise and fall time from 20 to 80 %.

Measurements with:

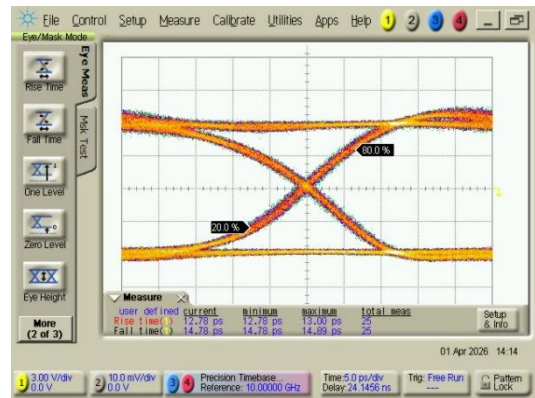
- SHF C911 A DAC generating binary signal (PRBS 2³¹-1)
- Agilent DCA 86100D with PTB 86107A and Sampling Head 86118A
- no Filter applied



20 Gbps 480 mV Input Signal

8.44 ps Rise time

7.67 ps Fall time



20 Gbps 12.1 V Output Signal

12.78 ps Rise time

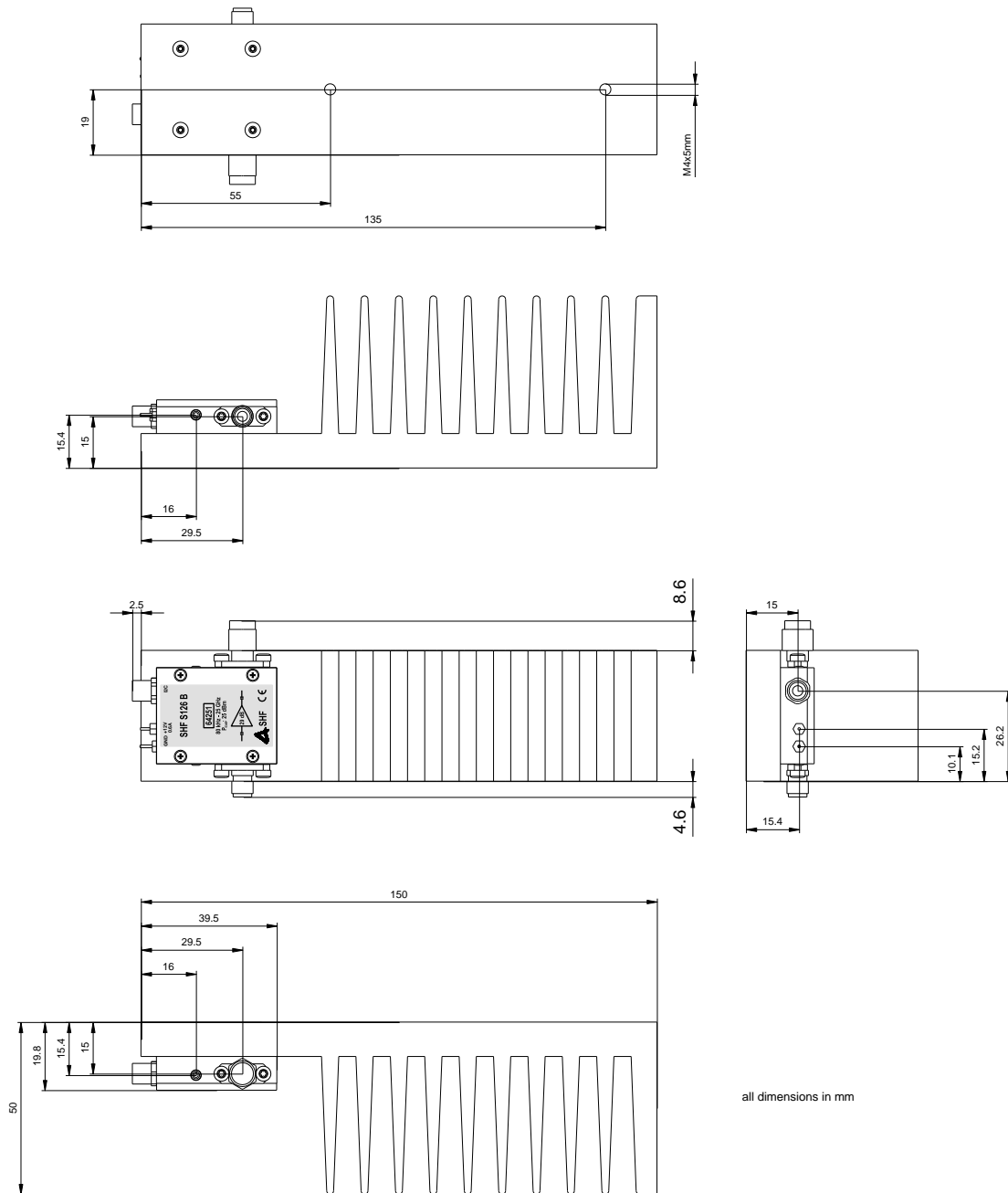
14.78 ps Fall time

$$t_{r \text{ deconvoluted}} = \sqrt{(t_{r \text{ full setup}})^2 - (t_{r \text{ setup w/o DUT}})^2} = \sqrt{(12.78 \text{ ps})^2 - (8.44 \text{ ps})^2} = 9.6 \text{ ps}$$

$$t_{f \text{ deconvoluted}} = \sqrt{(t_{f \text{ full setup}})^2 - (t_{f \text{ setup w/o DUT}})^2} = \sqrt{(14.78 \text{ ps})^2 - 7.67 \text{ ps}^2} = 12.6 \text{ ps}$$



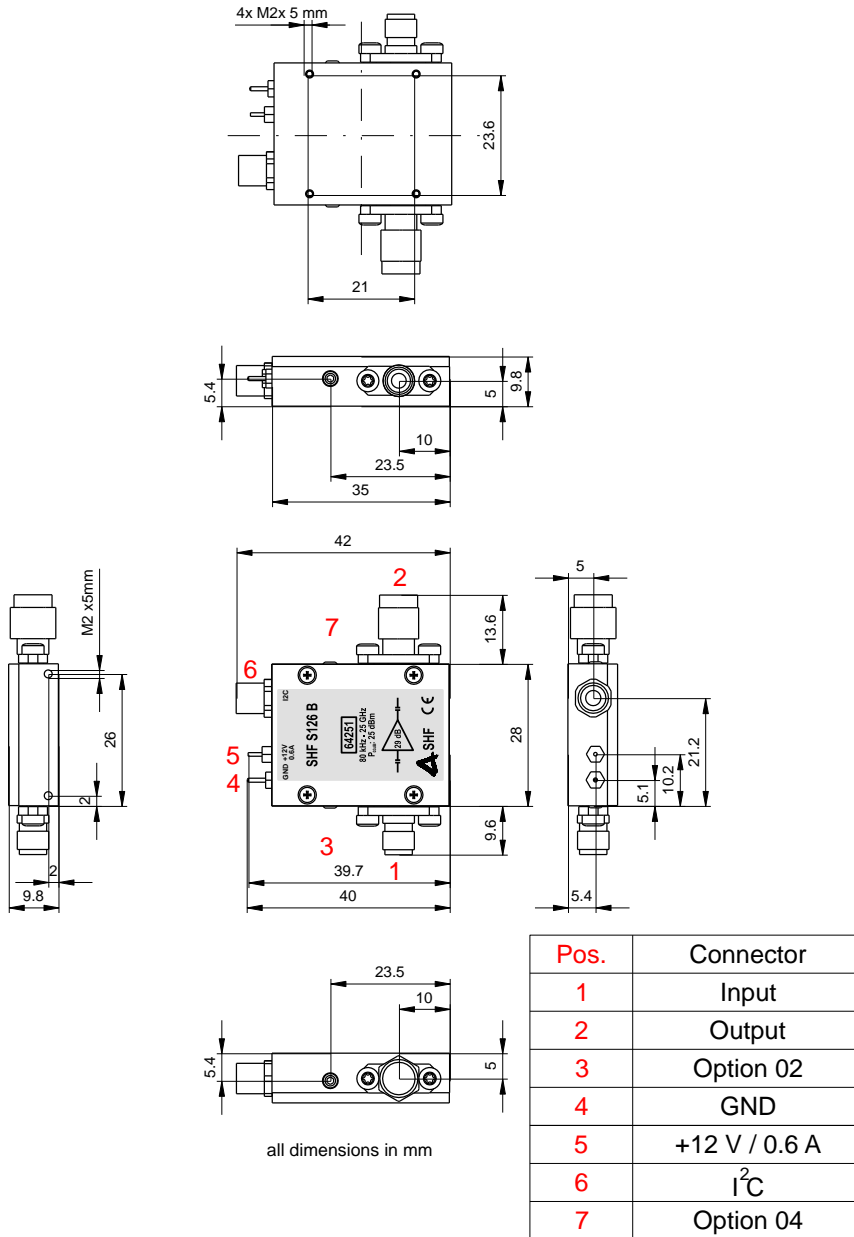
Mechanical Drawing with Heat Sink



For permanent mounting remove the heat sink from the amplifier. In that case, please ensure that adequate cooling of the amplifier is guaranteed. It is recommended to use thermal paste or a thermal gap pad for the mounting. In order to separate the heat sink from the amplifier, remove the four screws on the heat sink. Please note a thermal gap pad is used between the heat sink and the amplifier housing.



Mechanical Drawing without Heat Sink



Please ensure that adequate cooling of the amplifier is guaranteed.

In standard configuration pin 3 and 7 are not mounted. If a bias tee (option 02 or 04) is included the DC bias can be connected to the mounted pin (BiasT). It is the same feed through filter like the supply pin 5.



User Instructions

Electrostatic sensitive device

1. To prevent damage through static charge build up, cables should always be discharged before connecting them to the amplifier!
2. First make the connections between amplifier, signal source and a 50 Ohm output load before supplying DC power to the amplifier!
3. The supply voltage can be taken from any regular 11...13 V, 1 A DC power supply and can be connected to the supply feed through filter via an ON / OFF switch. Do not increase the supply voltage slowly from 0!
In case 12 V are applied to the amplifier typically 0.5 A are drawn during operation. However, the amplifier requires more current during start up. This is particularly important in case the current compliance of a very fast acting voltage source is set too tight. As this can prevent the amplifier from starting properly, please allow up to 100% overhead for your current compliance during startup.
4. Using a 3 dB or 6 dB input attenuator will result in a 6 dB or 12 dB increase of the input return loss. For minimal degradation of amplifier rise time, these attenuators should have a bandwidth specification of greater 30 GHz (K / 2.92 mm attenuators)!
5. While using a reflective load the output voltage has to be reduced to a safe operating level according to the magnitudes of the reflections.
6. ATTENTION: At radio frequencies a capacitive load can be transformed to an inductive one through transmission lines! With an output stage driven into saturation this may lead to the immediate destruction of the amplifier (within a few ps)!
7. The input voltage should never be greater than 1 Vpp equivalent to 4 dBm input power. In case an AWG is used as signal source, please check the maximum output voltage and be careful with the filter settings, while the amplifier is connected.
8. In case a bias tee is connected to the amplifier, please note that abrupt connection or disconnection of the RF port of such bias tees may cause harmful transients. Therefore, it is always recommended not to connect or disconnect bias tees under bias voltage. For example, ramp down the bias to 0 V before lifting a waver prober. In case of a short circuit, first ramp down the bias to 0 V then open the short.
9. For the DC-connections flexible cables 0.33 ... 0.5 mm² / AWG 22 ... 20 are recommended. A maximum soldering temperature of 260 °C for 3 seconds is recommended for the feedthrough (positive supply voltage and bias tee pin). The ground pin requires significantly more heat as it is connected to the solid housing.



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